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Improving Joint Operation System of Reservoir Groups in the Yangtze River Basin: A Legal Discussion

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Abstract

As China's largest river basin, the Yangtze River Basin has the most mega reservoir groups worldwide. To protect the entire basin, the Central Government developed a system of joint operations of key reservoir groups in the Yangtze River Basin. This paper examines this joint operation system from a legal perspective and discusses its implementation as well as the challenges in practice. The following issues impede the effective implementation of the joint operation system: a lacking legal basis for the system, limitations related to the organizations that participate in the joint operations, limitations on the scope and objects of the joint operation system, and a lacking systematic structure for operation. This paper offers suggestions to improve the system.

Keywords

Yangtze River Basin – multiple reservoir groups – joint operation system – flood control

1 Introduction

As the longest river in China, the Yangtze River is bestowed with abundant water-related resources, its runoff accounts for 36% of the total runoff of all the rivers in China.[1] The total hydropower resources in the Yangtze River Basin rank first across the nation. As a result, the Yangtze River basin is the key area for hydraulic engineering in China, with over 300 large-scale reservoirs (a large-scale reservoir has a total storage capacity of over 100 million m^3), forming the largest group of mega reservoirs in the world. These reservoir groups cross 10 provinces (and municipalities) and affect a total population of 400 million.[2] Most reservoirs provide at least two of the following benefits: flood control, hydroelectricity generation, water supply, irrigation, shipping, aquaculture, and tourism.

The reservoir operations in the same basin interact with each other: a single reservoir's action in storing or discharging water will change the hydrological characteristics of the entire river and trigger chain reactions in the lower reaches. The Central Government developed a joint operation system for the key reservoir groups in the Yangtze River basin to protect the entire basin. Its joint operation system of reservoir groups (henceforth JOS-RG) is the research focus of this paper. Existing research on the joint operation of reservoir groups mainly focuses on engineering and technology aspects;[3] a legal perspective is missing, and this paper fills that gap. This article is also intended to provide inspiration to the Yangtze River Basin Water Projects Joint Operation Management Measures which is currently in draft.

The research scope of this paper covers the entire Yangtze River Basin including 41 controlled reservoirs. The sources of the research data are the *Result of the National Water Resource Review* and the *Comprehensive Plan for the Yangtze River Drainage Basin 2012–2030* (National Development and Reform

1 Lyuliu LIU, et al. 'Predictability of Seasonal Streamflow Forecasting Based on CSM: Case Studies of Top Three Largest Rivers in China' (2021) 13 Water 2, 162.

2 Junjun ZHU, Li PENG. 'From "Solo" to "Ensemble" – Joint Operation of Reservoir Groups in the Upper and Middle Reaches of the Yangtze River' (2017) *China Water* <http://www.chinawater.com.cn/newscenter/kx/201806/t20180628_716071.html>.

3 See Mufeng CHEN, et al. 'Multi-objective Joint Optimal Operation of Reservoir System and Analysis of Objectives Competition Mechanism: a Case Study in the Upper Reach of the Yangtze River' (2019) 11 Water 12, 2542. Yuanfang CHAI, et al. 'Influence of Climate Variability and Reservoir Operation on Streamflow in the Yangtze River' (2019) 9 Scientific Reports 1, 1–10. Chao ZHOU, et al. 'Optimal Operation of Cascade Reservoirs for Flood Control of Multiple Areas Downstream: A Case Study in the Upper Yangtze River Basin' (2018) 10 Water 9, 1250. Yassin, FUAD, et al. 'Representation and Improved Parameterization of Reservoir Operation in Hydrological and Land-surface Models' (2019) 9 Hydrology and Earth System Sciences 23, 3735–3764.

Commission, 2005); the *Water Resource Report on the Yangtze River Drainage Basin and Other Rivers in Southwest China* (YRC, published between 2012 and 2018; the *Plan for Joint Operation of Reservoir groups in the Upper Reach of the Yangtze River* for the years of 2012, 2014, 2017, and 2019; the *2018 Plan for Joint Operation of Reservoir Groups in the Upper and Middle Reaches of the Yangtze River*; the *Yangtze River Flood Control Plan*, the *Wu River Flood Control Plan*, the *Han River Flood Control and Water Regulation Plan*, the *Optimized Operation Plan for the Three Gorges Reservoir*, the *Flood Season Operation Plan for the Cascading Reservoirs of Xiluodu, Xiangjiaba, Three Gorges, Gezhouba, and Qingjiang*, the *Flood Season Operational Plan for the Three Gorges – Gezhouba Dams*, and the *Sustainability Report of China Three Gorges Corporation* between 2015 and 2017 approved by the State Flood Control and Drought Relief Headquarters (SFCDRH). Information has been collected through interviews and workshops. Four meetings were organized with the Yangtze Command Center (YCC) and Administration Bureau of Joint Operation of Reservoir Groups) in December 2015, April and December 2016, and May 2017 and discussed the current situation and outstanding issues in the JOS-RG, as well as recommendations on improving the system.

The rest of the paper is structured as follows: Section 2 introduces the JOS-RG, including the legal basis, the participants and scope of the joint operations, and the actual results achieved by the system over the past 10 years. Section 3 discusses the operational challenges of the JOS-RG from a legal perspective. Section 4 develops legislative recommendations. The last section concludes.

2 Current Situation

The JOS-RG refers to a coordinated management approach for a group of reservoirs and their related projects within the same drainage basin. In practice, joint operations include flood control operations, drought relief operations, and emergency response operations.[4]

The JOS-RG was first implemented in 2010 in China, and to date, 41 controlled reservoirs are incorporated in the JOS-RG. Controlled reservoirs in this article are the water hydrological projects built on the mainstream of the Yangtze River or its main tributaries with a certain regulated storage capacity. These projects have a variety of functions, such as flood control, hydroelectricity generation, water supply, and shipping; they play a key role in the development,

4 Jun Guo, etc. 'Joint Operation of Reservoir Groups' (2011) *China Institute of Water Resources and Hydropower Research* <http://www.iwhr.com/zgskyww/ztbd/dbzhw/fifth/webinfo/2011/01/1294879661055982.htm>.

exploitation, conservancy, and protection of the river and the entire basin and exert significant, far-reaching, and unique influences on the management of the basin.[5]

2.1 *Legislative Basis*

Aside from the Yangtze River Basin Water Projects Joint Operation Management Measures (which are still in draft at the time of writing), there is no specific law or regulation for JOS-RG in China, instead, the regulatory provisions related to the JOS-RG are dispersed over a number of laws, regulations, and administrative requirements, such as the *Water Law*, *Flood Control Law*, *Yangtze River Protection Law, Reservoir and Dam Safety Regulation, Flood Control Regulation, Drought Relief Regulation, etc.* (*Table 1*), they provide the legal basis for the JOS-RG. Detailed requirements for the JOS-RG are specified in various plans and policy documents, including the *Comprehensive Plan for the Yangtze River Drainage Basin 2012–2030*, the *13th Five-Year Plan for Water Conservancy Reform and Development*, the *Ecological Environment Protection Plan for the Yangtze River Economic Belt*, the *13th Five-Year Plan for Development of Hydroelectricity (2016–2020)*, etc.[6]

TABLE 1 Legislative basis for the JOS-RG in the Yangtze River Basin

Water Law	Articles 20, 21, 22, 26, 30, 45, and 46.
Flood Control Law	Article 44, paragraph 1 During the flood season, use of reservoirs, dams, and other water-related facilities must comply with orders and supervision of the flood control command centers.
The Yangtze River Protection Law	Article 32 Relevant departments under the State Council and all local people's governments in the Yangtze River basin shall take measures to … strengthen the joint operation of water projects, …, establish flood prevention and disaster mitigation engineering and non-engineering systems that are compatible with economic and social development, and improve the overall ability to prevent floods and droughts.

5 Huazhong ZHANG & Fuji YU, 'Examining the Characteristics of Key Reservoir groups' (2010) 10 Yangtze River. Jianhua MA, 'Deliberation on Several Issues related to Joint Operation of Key Reservoir groups in the Yangtze River Basin' (2012) 9 Yangtze River.

6 This is not an exhaustive account of all the legislative provisions on the joint operation of key reservoir groups in the Yangtze basin, but it covers the main laws, regulations, procedures, and plans.

TABLE 1 Legislative basis for the JOS-RG in the Yangtze River Basin (*cont.*)

Reservoir and Dam Safety Regulation	Article 21, paragraph 2 During the flood season, the operation of reservoirs with comprehensive functions must follow orders of the flood control command centers; for reservoirs whose main function is hydroelectricity generation, the flood control storage above the flood limit water level as well as water supply and usage must follow orders of the flood control command centers.
Drought Relief Regulation	Article 37 When there is a drought, the flood control and drought relief command center of a county-level government or above, or the flood control and drought relief command center of a drainage basin, in accordance with pre-approved plans, may develop emergent water supply plans and coordinate supply of water stored by all the reservoirs, hydroelectric power plants, dams, and lakes within their jurisdiction. Local governments, organizations, and individuals must strictly follow and implement the orders.
Regulation on the Administration of the Lake Tai Basin	Article 40, paragraph 1 Only the Lake Tai Command Center for Flood Control and Drought Relief (referred to the "Lake Tai Command Center" hereafter) can issue orders on flood control and drought relief for the following facilities: the Taipu Dam and pumps on the Taipu River, the Jiangbian Dam and Canal Dam on the Xinmeng River; and the Wangting Dam and Changshu Dam on the Wangyu River; this requirement also applies to other water conservancy projects that have major impacts on flood control and drought relief as specified by government authorities.
Flood Control Regulation	Article 26 During the flood season, administrators of river channels, reservoirs, dams, and marine shipping facilities as well as the authorities that they report to must follow the operational orders and accept supervision of the flood control command centers of the local governments that have jurisdictions over this matter.

TABLE 1 Legislative basis for the JOS-RG in the Yangtze River Basin (*cont.*)

	During the flood season, for reservoirs whose main function is hydroelectricity generation, the flood control storage above the flood limit water level as well as water supply and usage must follow orders of the flood control command centers of the local governments that have jurisdictions over this matter.
Administrative Procedures for the Operation of the Three Gorges Reservoir and Management of Water Resources and River Channels	Chapter 1 General rules Chapter 2 Reservoir operation
Regulations on Management of the South-to-North Water Diversion Project	Chapter 2 Water volume coordination
Comprehensive Plan for the Yangtze River Drainage Basin 2012–2030	Strengthen the joint operation of key water conservancy projects on the mainstream of the Yangtze River and its tributaries with the Three Gorges Dam at their center; balance the relationship between flood control and comprehensive use of water resources as well as protection of the water's ecological environment; and raise the capacity to withstand extra-large floods in the drainage basin.
Flood Control Plan for the Yangtze River Drainage Basin	Build reservoirs with large flood control storage capacities while also considering comprehensive use of water resources on the rivers in the upper reaches of the Yangtze River …; these reservoirs should be operated jointly with the Three Gorges Dam to increase the flood control capacity.

TABLE 1 Legislative basis for the JOS-RG in the Yangtze River Basin (*cont.*)

13th Five-Year Plan for Water Conservancy Reform and Development	Optimize operations of water conservancy projects. Comprehensively consider the upper and lower reaches, the main rivers and tributaries, and left and right banks, and balance flood control and water storage; in accordance with the principles of "safety first, controllable risks, and maximal benefits," develop reasonable operation plans for various types of water conservancy projects, make the operation more scientific, refined, and normalized; enhance the joint operation of cascading reservoirs, and maximize the benefits gained from comprehensive use of water resources in the drainage basin.
Guiding Opinions on Enhancing Interconnectedness between Rivers, Lakes, and Reservoir groups by Ministry of Water Resources	Strengthen management of the interconnected projects and focus on the coordination between water quantity, water quality, and the water's ecological environment of the interconnected projects; enhance coordination between operations for flood control, water supply, and ecosystem protection for interconnected rivers and lakes.
Ecological Environment Protection Plan for the Yangtze River Economic Belt	Enhance joint operation of water resources. Implement the JOS-RG in the Yangtze River Basin in accordance with the principles that "flood control takes priority over generating benefits from water resources." Coordinate the operational needs of flood control, water supply, irrigation, transportation, and hydroelectric power generation; optimize the processes of storing and discharging water by reservoir groups; make the best use of the flood control, water supply, and ecological functions of large hydroelectric projects.... Operate the cascading reservoir groups in the upper reaches of the Yangtze River in a scientific manner. Exploitation of cascading reservoir groups in a drainage basin must follow the comprehensive plans for the basin as well as plans for flood control. Joint operations should be implemented for existing cascading reservoir groups in the upper reaches of the Yangtze River in a scientific manner; and while safeguarding flood control and water supply, the joint operation should try to maximize the ecological benefits of the reservoir groups.

TABLE 1 Legislative basis for the JOS-RG in the Yangtze River Basin (*cont.*)

13th Five-Year Plan for Development of Hydroelectricity (2016–2020)	Develop a cascading joint operation system. Employ a coordinated approach to consider utilization of water resources, optimize hydroelectric power plant operations, and increase efficiency in using water resources. Conduct research on the cascading joint operation system in the drainage basis; coordinate the requirements of power generation, flood control, water supply, shipping, irrigation, ecology, and safety; develop procedures and technical standards for the joint operation of cascading hydroelectric power plants; and maximize the overall benefits from development of cascading hydroelectric power plants in the drainage basin. Develop coordination mechanisms for operation of hydroelectric power plants. Coordinate comprehensive monitoring of river basins and joint optimization of cascading operations; in the Dadu River, Jinsha River and other river basins, gradually establish coordination mechanisms for the development, operation, and management of the basins.

2.2 *Participants and Scope*

In accordance with the above-mentioned laws and regulations, the main participants in the JOS-RG are the various levels of command centers for flood control and drought relief, including the State Flood Control and Drought Relief Headquarters, the YCC, the Lake Tai Command Center, and the command centers of the provinces (autonomous regions and municipalities). Of the command centers, the YCC is the most important player. Tasked with managing all efforts related to flood control and drought relief in the entire basin, the YCC, under the guidance of the SFCDRH, coordinates all command centers in the basin.

The SFCDRH is a coordinating agency of the State Council (responsible for coordinating important cross-ministry tasks of the State Council) and leads nationwide efforts in flood control and drought relief. After the structural reform of the State Council in 2018, mitigation of flood and drought disasters and the responsibilities of the SFCDRH were moved to the Ministry of Emergency Management. Under the leadership of the SFCDRH, the YCC leads the work of flood control and drought relief in the Yangtze River basin. The

YCC consists of representatives of the 8 provinces and municipalities along the Yangtze River, the YRC, the China Meteorological Administration, the Changjiang River Administration of Navigational Affairs of the Ministry of Transport, the State Grid Corporation of China, the China Southern Power Grid Company Limited, and the China Three Gorges Corporation.

The YCC sets its general office, the operational arm for the center's day-to-day business, within the YRC. The general office assumes the responsibilities of coordinating, guiding, and supervising all work in flood control and drought relief within the Basin. To better implement the joint operation of water conservancy projects, the general office also established the Administration Bureau of Joint Operation of Reservoir Groups to manage the JOS-RG.

The China Three Gorges Corporation is also a participant of the JOS-RG. Since 2015, this company has been conducting joint operations on four mega hydroelectric power projects, including the Three Gorges, Gezhouba, Xiluodu, and Xiangjiaba, and performed well in reaping the comprehensive benefits.

Under the existing laws and regulations, the JOS-RG consists of flood control, drought relief, and emergency responses; the geographic area of the operation is limited to the upper and middle reaches (including its tributaries), and the object of the joint operation is controlled reservoirs. As a result of the ever-increasing number of reservoirs and the demand for flood control, the number of reservoirs incorporated into the joint operation system has been growing. Under the first joint operation plan approved by the SFCDRH in 2012, the *Plan for Joint Operation of Multi-Reservoirs in the Upper Reach of the Yangtze River 2012*, only 10 reservoirs were included in the scheme. As of 2020, the total number of water conservancy projects incorporated into the plan has reached 101, including 41 controlled reservoirs, and the total flood control storage capacity has reached 59.8 billion m^3.

2.3 *Implementation*

In accordance with the principle that "flood control takes priority over generating benefits from water resources,"[7] flood control is the top priority of the JOS-RG, which is also why the joint operation system was originally introduced. In practice, the JOS-RG has achieved significant outcomes. For instance, in the fall of 2011, two tributaries in the upper and middle reaches, the Jialing River and Han River, suffered from autumn floods. The YCC coordinated operations of the reservoirs in the upper and middle reaches, successfully stabilized the

7 Ministry of Ecology and Environment, '*Ecological Environment Protection Plan for the Yangtze River Economic Belt*' (2017), No. 88.

flow of water in the middle and lower reaches and eased their flood pressure.[8] In 2016, the YCC coordinated joint operations of multi-reservoir groups in the upper and middle reaches during the flood season, and stored floodwater in the amount of 22.7 billion m^3; this operation avoided the need to use the flood diversion areas in the lower reaches and the consequent losses that otherwise would have occurred.[9]

The JOS-RG also plays an important role in relieving droughts and dealing with emergencies. The YCC coordinates water storage efforts between key reservoirs each year by the end of the flood season to prepare for water replenishment during the drought period. In 2013, due to serious low water flows at the end of the flood season, the reservoir groups had difficulties in reaching their water storage targets. In response, the YCC implemented several measures, such as moving up the time to start water storage and coordinating water storage activities to avoid peak times of water consumption, and eventually helped the reservoirs reach their storage goals.[10] Related to emergency management, in March 2016, the Han River was inflicted with a water bloom. Under the guidance of the YCC, the CCFCDR of the Hubei Province coordinated emergent water flow controls on the Han River and directed reservoirs to increase their water discharge volumes; these efforts effectively alleviated the water bloom issue.

3 Challenges

The JOS-RG, while still in a phase of exploration, falls short in achieving its policy goal for a holistic and coordinated approach to the utilization of water-related resources. This section examines the deficiencies from a legal perspective.

3.1 *Insufficient Legal Basis*

Since the existing legislative framework is limited to flood control, drought relief, and emergency management, the authority to command joint efforts

8 Zhong SHEN, 'Ministry of Water Resources Self-identifies Issues: Flood Control in the Yangtze Basin Still Has Four Major Weaknesses' (2011) <http://www.thepaper.cn/baidu.jsp?contid=1482115>.

9 Xingwang CHEN and Qi LIU, 'Ministry of Water Resources Self-identifies Issues: Flood Control in the Yangtze Basin Still Has Four Major Weaknesses' (2016) <http://www.thepaper.cn/baidu.jsp?contid=1482115>.

10 China Yangtze Power Co., Ltd. 'Social Responsibility Annual Report' (2015) <https://www.cypc.com.cn/cypcweb/cypc/accessory/upload/2016/5/18182910167.pdf>.

of reservoir groups is restricted to the above circumstances. There is no mandate for joint operations under other circumstances under the current legal framework. A decade of experience shows that the JOS-RG can also help achieve other functions of water resources, such as shipping and ecosystem protection. Each year during the flood season serious delays occur in vessel movement. In that case, the Changjiang River Administration of Navigational Affairs requests the YCC joint operations of reservoirs to help with navigation and address the emergency. In July 2018, limited by the navigable water volume between the Three Gorges Dam and the Gezhouba Dam, many vessels were stranded in the Three Gorges waterway. The number of vessels lining up to pass the dam once reached 738, and over 10,000 crew members were stranded for up to 20 days. At the request of the Three Gorges Navigation Authority, the YCC coordinated operations between the Three Gorges Dam and the Gezhouba Dam and helped to disperse the stranded ships and personnel.[11] During the period of July and August 2018 alone, the YCC performed four similar joint operations for navigation, all on an ad hoc basis. These ad hoc joint operations do not constitute an institutionalized arrangement, the scope and specific matters of each joint operation are determined on a case-by-case basis through administrative orders. As a result, stakeholders who participate in these joint operations often do not understand their rights and obligations.

3.2 *Limitations Related to Participants*

There is a wide range of stakeholders involved in the JOS-RG. At present, the main organization responsible for the JOS-RG is the YCC. Membership consists of the parties mentioned above but major stakeholders, such as government departments responsible for the ecology and environment, energy, agriculture, and their supervisory authorities and the firms that operate the reservoirs, are not members of the YCC. As a result, when carrying out joint operations (e.g., developing plans, conducting consultations, and issuing orders related to joint operations), the YCC is unable to consider the legitimate appeals of all stakeholders and may hurt their interests. For instance, the *13th Five-Year Plan for Hydro Power Development* published by the National Energy Administration expressly requires the promotion of joint operations between cascading hydroelectric power plants. However, the administration is not a member of the YCC and its interest is difficult to consider in YCC's joint operations. Further, the firms that manage the key controlled reservoirs, such as the Jinzhong

11 Xinghua ZHANG, 'Yangtze Command Center Helps to disperse Stranded Vessels in the Three Gorges Waterway through Joint Operation of Reservoir groups' (2018) <http://www.gov.cn/xinwen/2018-08/15/content_5314057.htm>.

Corporation, the Hanergy Holding Group Ltd., the China Huaneng Group, and the China Huadian Corporation, are closely related to the joint operations of the reservoir groups but are not members of the YCC either; as such, they are also at disadvantaged positions in the joint operations.

In summary, the limit on the membership of the YCC prevents it from considering and balancing the interests of all stakeholders in implementing the JOS-RG. This limitation not only affects the resolution of conflicts in joint operations but may also cause new conflicts.

3.3 *Limited Scope and Functions*

The current JOS-RG does not cover the entire Yangtze River Basin. The geographical scope of the JOS-RG is limited to the upper and middle reaches. The operation of reservoir groups in the lower reaches is still independent of the JOS-RG. For instance, the operation of reservoir groups in the Lake Tai basin in the lower reaches is conducted by the Lake Tai Command Center. Due to this, there is a break between the JOS-RG in the upper-middle reaches and the lower reaches, which makes it difficult to manage floods over the whole Basin.

Additionally, neither non-controlled reservoirs nor all of the controlled reservoirs are included in the joint operating plans. Regarding the controlled reservoirs, the Poyang Lake Exit was added to the middle reach as part of the *2018 Plan for Joint Operation of Reservoir Groups in the Upper and Middle Reaches of the Yangtze River*. The number of controlled reservoirs incorporated into the joint operation system increased from 28 in 2017 to 41 in 2020, which however accounts for only a small proportion of the over 300 large-scale reservoirs. In addition, non-controlled projects, such as culverts, canals, floodgates, and weirs, that are not included in the joint operation system, have also a major impact on flood control, water storage adjustment, drought relief, etc.

3.4 *Planning Deficiencies*

Instead of specifying the activities themselves, Chinese legislation frequently addresses the administrative authorities in charge of the relevant sector at various levels and calls on them to establish the required bylaws or operation plans.[12] In light of this, the above-mentioned JOS-RG plans created by various agencies serve as the foundation for action. The scope of these relevant plans, however, varies. For example, some solely focus on particular projects while

12 Ignazio CASTELLUCCI, 'Rule of Law and Legal Complexity in the People's Republic of China' Università degli studi di Trento, 2012, 12.

others cover the entire Yangtze River basin. Conflicts have arisen in practice as a result of the unclear links between these plans and the relevant authorities.

The approving authority of the plans varies as well. Some plans are approved by the State Council, such as the *Yangtze River Flood Control Plan* and the *Optimized Operation Plan for the Three Gorges Reservoir*; while others are approved by the SFCDRH, such as the *Plan for Joint Operation of Reservoir Groups in the Upper and Middle Reaches of the Yangtze River*, the *Han River Flood Control and Water Regulation Plan, and* the *Plan for Regulating Floodwater on the Yangtze River*. There are overlaps between these plans in terms of the areas covered. For instance, the scope and objects identified in the *Plan for Joint Operation of Reservoir groups in the Upper and Middle Reaches of the Yangtze River* overlap with those identified in the *Wu River Flood Control Plan*. Four water conservancy projects on the Wu River – Goupitan, Silin, Shatuo, and Pengshui – are subject to both plans; the content of the two plans, however, is not the same. Which plan that these four projects should follow in practice remains an open question.

4 Recommendations

The design of the JOS-RG is a complex, systematic project because it must not only consider the needs of the upper and lower reaches and of the regions on both the left and right sides of the river. Also, the needs of a variety of government departments and industries, as well as needs of water conservancy, transportation, electric power, environment protection, and land conservation. These needs differ during the year depending on the flood season. Since an operation plan can affect the lives and property of hundreds of thousands, or even millions of people; it is of paramount significance to design it carefully, taking all needs and interests into account. This research leads to the following legal recommendations.

4.1 *Improve the Institutional Mechanism*

Given the wide range and diversity of stakeholders involved in the JOS-RG, this paper recommends expanding the membership of the YCC. Specifically, the government departments responsible for ecological protection, energy, and agriculture in the Yangtze River Basin should become members of the YCC. The membership should also be extended to firms that manage key water conservancy projects. When developing joint operation plans and when conducting consultations for flood control and drought relief, and issuing operational orders, the YCC should employ a coordinated approach and

consider the comments and suggestions of all stakeholders to make the joint operation plans inclusive and thus more operational.

In addition, the allocation of authority over the JOS-RG needs to be improved. It is recommended that the current operators of reservoir groups have full discretion over the operation only under the following two circumstances: during the flood season when the actual water level is below the flood limit water level, and during the non-flood season when the stakeholders of the reservoir groups do not have specific requirements for the volume of water discharge. However, when the operation of reservoir groups only affects the province or municipality where the reservoir groups are located, the corresponding provincial or municipal command center for flood control and drought relief should have the authority to mandate joint operations. After the operation, the municipal command center should file the operation with the YCC for Records. When coordination between the reservoirs at the upper, middle, and lower reaches is required to activate flood control operations, navigation operations, ecological operations, and emergency response operations at the entire drainage basin level, the YCC should execute its authority.

4.2 *Expand Scope and Objectives*

It is advised to extend the joint operation to the lower reach in order to cover the entire basin. The Lake Tai Command Center's water projects in the lower reaches have a big impact on the basin's ability to manage floods and droughts. In practice, the joint operations of controlled reservoirs in the whole Yangtze River basin require coordination and cooperation between the YCC and the Lake Tai Command Center, which has raised operational costs and increased the risk of conflict. Therefore, it is advised that the reservoir operation power of the Lake Tai Command Center be integrated into the YCC while other functions, such as water monitoring and water resource protection, remain unchanged.

It is also advised to incorporate activities for navigation and ecological preservation in the current scope of flood control, drought relief, and disaster management. To ensure shipping safety and assist transportation, the shipping operations should be set up as a separate goal of operation from emergency management operations.

In addition, the non-controlled water conservancy projects should also be incorporated into the joint operation plan to realize full coverage of all projects.

4.3 *Integrate and Streamline Joint Operation Plans*

Operational principles for the current joint operation plans could be formulated in light of the shortcomings with those that are currently in existence.

The Yangtze River Protection Law mandates that relevant departments under the State Council and all local people's governments in the Yangtze River basin shall take measures to … strengthen the joint operation of water projects. Taking this as an opportunity, the YCC could be given permission to integrate and improve the relevant plans of the JOS-RG. As a result, jurisdictions will be more clearly defined and plans will be better integrated and coordinated, reducing conflicts during implementation. The following recommendations are made: first, the approving authority should serve as the foundation for the plan hierarchy. Plans approved by the SFCDRH and the YCC come after those by the State Council. Second, Plans covering the entire drainage basin should have the most authority; followed by plans covering the mainstream or tributaries. Plans that only address specific projects have the least amount of authority. Third, balancing competing interests and setting priorities, for example, what takes precedence when flood control conflicts with other functions.

The YYC should be in charge of organizing all member organizations throughout the planning stage. To consider all interests, there must be adequate consultation and information sharing. Additionally, the drafted plans are suggested to be approved by SFCDRH before being implemented. The scope, purposes, principles, goals, specific plans, operational processes for various reservoirs, and participation authorities should all be clearly stated in the joint operation plans. In addition to information sharing, monitoring and performance evaluation should also be in place to safeguard the implementation of the plans.

5 Conclusion

This paper examines the JOS-RG in the Yangtze River Basin. While confirming the results achieved through the joint operation system, this research also identifies some legal deficiencies in the existing system: the lack of a legal basis prevents the joint operation system from resolving the conflicts between multiple functions of water resources; the limitation on the participants prevents the joint operation system from considering the interests of all stakeholders and managing all conflicts related to the functions of water resources; the limitation on the scope and objectives of the joint operation system prevents it from being implemented across the entire basin, and the limitation on its goals prevents it from resolving the conflicts between water resource functions; the absence of a systematic structure of the joint operation plan creates conflicts between different plans and makes implementation challenging in practice. In order to respond to the Yangtze River Protection Law, and fulfill the goal

of the *13th Five-Year Plan for Water Conservancy Reform and Development that* enhance the joint operation of reservoirs, the recommendations of this paper are to involve more stakeholders in the joint operation system, reasonably allocate authority over joint operations, establish a coordination mechanism for joint operations, and integrate and streamline existing joint operation plans to maximumly realize the reservoirs' comprehensive functions.

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